Journal of Plant Development
Vol. **29**, Dec **2022**: 69-77
doi: 10.47743/jpd.2022.29.1.904

ISSN 2065-3158 print / e-ISSN 2066-9917
Available online: www.plant-journal.uaic.ro

NUTRITIONAL AND EXTRACTABLE OIL PROFILE IN SEEDS OF *SESAMUM INDICUM* L. AND *MORINGA OLEIFERA* LAM. GROWN IN SOKOTO, NIGERIA

Ibrahim Umar KARAYE[1*], Sa'idu Muhammad MAISHANU[1], Sule Aliyu ANKA[1], Abubakar SHEHU[2], Shafi'u Isma'ila ADILI[2], Lawal Hannatu MUHAMMAD[2], Aisha MUSA[1]

[1] Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto – Nigeria.
[2] Department of Biology, Shehu Shagari College of Education, Farfaru, Sokoto – Nigeria.
* Corresponding author. E-mail: inaguraguri@gmail.com, ORCID: 0000-0002-1638-1632

Abstract: Nutritional and extractable oil profile in seeds of *Sesamum indicum* L. and *Moringa oleifera* Lam. were investigated using standard biochemical procedures. Proximate analysis revealed % crude protein contents of 24.32% in *S. indicum* while *M. oleifera* had 27.66%. Crude lipid contents were analyzed and 47.78% was obtained in *S. indicum* while 28.87% was obtained in *M. oleifera*. Crude carbohydrate analysis revealed *S. indicum* with 37.89% while in *M. oleifera*, it was 34.51%. Crude fibre obtained was 11.32% in *S. indicum* while 9.37% was identified in *M. oleifera*. Higher ash content of 9.13% was obtained in *M. oleifera* while 7.62% was obtained in *S. indicum*. Available energy (k/cal.) was analyzed in the samples with obtained values in *S. indicum* 692.22 k/cal. While *M. oleifera* had 545.91 k/cal. With significant difference (P≤0.05) between the two species in terms of available energy (k/cal.). Results of extractable oil profile of *S. indicum* and *M. oleifera* revealed appreciable amounts of the oil with 54.65% found in *S. indicum* while *M. oleifera* had 39.33% with significant difference (P≤0.05) between the two species. Physico-chemical properties of the seed oils analyzed include, acid value determined with 34.32 mg $KOHg^{-1}$ for *S. indicum* and 29.98 mg $KOHg^{-1}$ obtained in *M. oleifera*. Saponification value of the two samples indicated that *S. indicum* had 148.82 mg KOH/g while *M. oleifera* had 127.88 mg KOH/g. Kinematic viscosity was determined and *S. indicum* had 0.97 mm^2/s while 0.78 mm^2/s was identified in *M. oleifera*. Iodine value was determined and *S. indicum* had 128.56 g l_2 /100 g while *M. oleifera* had 103.68 g l_2/100 g. Specific gravity was determined with 0.89 g/cm3 obtained in *S. indicum* while 0.84 g/cm^3 was obtained in *M. oleifera*. Cetane number was determined; *S. indicum* had 34.00 while 30.00 was obtained in *M. oleifera*. Oil colour was determined and the colour ranged from yellowish-brown to creamy-yellow for *S. indicum* and *M. oleifera* respectively with no significant difference (P≤0.05) in iodine number, acid value, kinematic viscosity and cetane number. State of the oil at room temperature indicated that the oils from the two seed types are liquid at room temperature. Mineral analysis of the two samples indicated that they comprise of appreciable amounts of minerals with phosphorus 385.51±4.96 mg / 100 g obtained in *M. oleifera* while in *S. indicum*, 254.54±4.06 mg / 100 g was obtained. Calcium was richly obtained in the two samples with 95.20 mg / 100 g obtained in *M. oleifera* while 66.70 mg / 100 g was obtained in *S. indicum*. However, potassium, manganese, copper, and magnesium were appreciably contained in the seeds with significant difference (P≤0.05) between the two samples. Thus, it can be recommended that seeds of *M. oleifera* especially and that of *S. indicum* should be properly incorporated in the diets especially in the developing countries where hunger and malnutrition ravage the growing children and pregnant women.

Keywords: Biofuel, minerals, *Moringa*, proximate-composition, *Sesamum.*

Introduction

Sesamum indicum L., commonly known as beniseed, sesame, is herbaceous plant grown in tropical countries such as Nigeria, India, China, Sudan, Burma, Bangladesh, Indonesia, Egypt and Tunisia. The species belongs to the family Pedaliaceae. Sesame seed has one of the highest

Received: 7 June 2022 / ***Revised***: 25 November 2022 / ***Accepted***: 29 November 2022

oil contents of any seed and is considered to be the oldest oil seed crop known to man, highly resistant to drought and is annual crop [DUTTA, 2004]. Its seed which contains approximately 5% of oil and very high quality (47% oleic acid and 39% linoleic acid) and 25% protein aseptically high in methionine and tryptophan. The oil is widely employed in cooking and in manufacture of margarine; antioxidant, beta-carotene, and steroids have also been found in Beniseed oil. The seeds have been valued throughout history for their contributions to diet (in snacks and as soup ingredient) medicine, industry and household use [YOSHIDA & al. 2001]. Beniseed is a cherished soup condiment in some parts of Nigeria-northern states, middle belt and parts of cross river state in Nigeria. The plant's root and leaves are used for treating migraine, hypertension, ulcers, constipation, chicken pox and piles [ODUGBEMI, 2006]. Beniseed could be regarded as one of the most ancient oil seed cultivated known to mankind [OKUDU & al. 2016]. It is a highly priced oil crop of some countries of the world; its seeds are used extensively in Asia and African because of its high contents of edible oil and proteins [MAKINDE & AKINOSO, 2019].

S. indicum grows in a well-drained soil; it survives standing water or high salinity environments. The plant is notable for its ability to grow under drought conditions and in extreme heat. It is often grown where cotton can grow, under conditions few other crops can survive, requiring very few water inputs. These attributes make the species an excellent candidate for low input sustainable food systems. *S. indicum* is deep-rooted and will scavenge nutrients from below most crop root zone. Generally, the plant will have a better chance of survival when it is grown in hotter than optimal temperatures rather than lower than optimal temperatures. Sesame ranked 2nd and 7th in the world in terms of beniseeds production, and Nigeria is one of the major producers of sesame and it is also among the key commercial crops in Nigeria [NAERIS, 2010].

Moringa oleifera Lam. belongs to the family Moringaceae which is single genus in the family of shrubs and trees cultivated across the whole of the tropical belt and used for a variety of purposes. *M. oleifera* is a native to Africa, Arabia, South Asia, South America, Sub Himalayan tracts of India, Pakistan, Bangladesh and Afghanistan, and it is the most widely cultivated out of the fourteen species in the family. *M. oleifera* is a small, fast-growing evergreen or deciduous tree that usually grows up to 10 to 12 m in height, with open crown of dropping fragile branches, feathery foliage of trip innate leaves and thick corky, whitish bark. When grown in soils, *M. oleifera* grows rapidly reaching high height; however, it can tolerate sandy soils, clay soils and water-limited conditions. *M. oleifera* is not a nitrogen fixing tree but its fruits, flowers and leaves all contain 5% to 10% protein on average. All of those parts are eaten widely as vegetable; providing excellent food for both human and animals. *M. oleifera* could be described as a monogenetic plant in the family of Moringaceae and it has long being cultivated and all its parts are being consumed and used for a variety of purposes [JAHN, 1984]. This is because of its impressive range of nutritional and medicinal values [BUKAR & al. 2010]. More so, OLUDURO (2012) reported the presence of the following minerals in the leaves sodium 11.86, potassium 25.83, calcium 98.67, magnesium 107.56, zinc 148.56, iron 103.75, manganese 13.55 among others in parts per million and nutrients such as carbohydrate 45.43%, proteins 16.15%, fats 9.68%, crude fibre 9.68%, moisture 11.76% and ash 10.64%.

The dry seed suspension is known to be a natural coagulant and coagulant aid. In northern Nigeria, the fresh leaves are used as a vegetable, roots for medicinal purposes and branches for demarcation of property boundaries and fencing. The seeds is instead have attracted scientific interest as *M. oleifera* seed kernel contains a significant amount of oil (up to 40%) with a high-quality fatty acid composition on (oleic acid >70%) and after refining, a notable

oxidative degradation. Moreover, after oil extraction, the seed cake can be used in waste water treatment as a natural coagulant or as an organic fertilizer to improve agricultural productivity. According to the Food and Agricultural Organization's (FAO) report, 70-80% of world's population especially in developing countries, relies on herbal medicine to prevent and cure diseases. In recent years, bio-energy source have become more important as available and economically alternative to diminishing and much expensive fossil fuels.

The rapidly growing global demand for petroleum products and the consequent depletion of the crude reserves in addition to adverse environmental concerns and unstable nature of the international market make imperative the need to explore alternative sources of fuel. Biodiesel stands to be the key promising renewable energy options already exploited by various countries. Categories of feedstock as source of suitable oil for biodiesel production include seeds, nuts, leaves, wood, and even bark of trees. Nigeria is very well endowed with various edible and non-edible oils [IBETO & al. 2012].

Materials and methods

Sample collection and preparation

Ripe pods of *Moringa oleifera* were sourced from the Garden of Government Girls' College within Sokoto metropolis while newly harvested seeds of Beniseed were sourced from the orchard in Sokoto, Sokoto state. The seeds were taken to the Departmental Herbarium, Department of Biological Sciences, Usmanu Danfodiyo University, Sokoto, where voucher specimens were deposited. The seeds were thereafter sun dried and seeds of *Moringa oleifera* were dehulled by removal of the shell in order to obtain the seed kernels. Sesame seeds were sorted out to remove good seeds from bad ones. Both the kernels of *M. oleifera* and Sesame were crushed using pestle and mortal and put in sterilized labeled bottles until used.

Extraction procedure for *indicum* and *Moringa oleifera* using Soxhlet extractor

Extraction of the Cucurbits seed oil. Extraction procedure

Adopting the method as reported by [AJIBOLA & al. 2018], two hundred (200) g of air dried and pulverized seeds of each of the sampled seeds will be weighed and packed into thimble, which will in turn be placed into Soxhlet extractor. The extraction solvent (n-hexane 500 cm^3) and anti-bumping chips are to be put into 1000 cm^3) round bottomed flask and heated on heating mantle at 60 °C. The extraction will be allowed to continue for one hour (1 hr). The solvent in the round bottomed flask will be collected and concentrated in vacuo using a rotatory evaporator at 40 °C. The above process will be repeated to get means of percentage extraction and enough oil for further analyses.

Percentage yields was calculated for each of the two samples using the equation bellow:

$$\text{Biodiesel yield (\%)} = \frac{\text{weight of the biodiesel}}{\text{weight of the sampled oil}} \text{x } 100$$

Physicochemical properties of the seed oil

Determination of the saponification value

The American Standard for Testing and Material (ASTM) method-[D 5558-95] was employed for the determination of the saponification values of the vegetable oil. The oil (5 g) was weighed into Erlenmeyer flask and 0.5 M ethanolic KOH to be prepared by dissolving 7 g of KOH in 250 cm ethanol and 25 cm^3 of the prepared 0.5 M ethanolic KOH was added and the resulting mixture refluxed for 60 minutes. The resulting solution was subsequently titrated

against 0.5 M HCl by diluting 10.7 cm HCl in 250 cm^3 of distilled water using phenolphthalein as indicator. The resulting end points was obtained when the pink colour changed to colorless. The same procedure was used for the blank. The Saponification value (SV) was calculated using the following expression:

$$\text{Saponification value (S.V.)} = \frac{5.61\ (B-S)\ x\ M\ of\ \ HCl}{\text{Weight of Sample}}$$

where, B – vol. of HCl required by blank, S – vol. of HCl required by sample. M – molarity of HCl, 5.61– molar mass of KOH.

Determination of acid value

Acid value of the oil will be determined by ASTM method (ASTM – D 974). The oil (0.5 g) of the oil will be weighed into 250 cm3 conical flask and 50 ml of neutralized ethyl alcohol was added, prepared by neutralizing a solvent mixture of 25 cm^3 5.61 (B-S) x M of HCl Weight of sample ethanol and 25 cm^3 diethyl ether with 0.1M ethanolic KOH was prepared by dissolving 1.4 g KOH in 250 cm^3 of ethanol using phenolphthalein as indicator. The mixture was added to the oil and heated on a water bath to dissolve the oil. The solution was then titrated against 0.1 M KOH prepared by dissolving 1.4 g of KOH in 250 cm of distill water using phenolphthalein as indicator. The acid value was determined after which the free fatty acid was respectively calculated using the following equations:

$$\text{Acid Value} = \frac{A\ x\ Mx\ 56.10}{W}$$

where, A = ml of 0.1M KOH consumed by sample, M = Molarity of KOH, W = weight in grams of the sample.

Determination of iodine value

The oil (0.5 g) will be weighed into conical flask and 20 $cm^3$of carbon tetrachloride was added to dissolve the oil. 25 $cm^3$of Wigs reagent was added into the flask using a measuring cylinder in a fume chamber and a stopper was inserted, the content of the flask was vigorously swirled and kept in the dark for 35 minutes. 20 cm of 10% aqueous potassium iodide was prepared by diluting 10 cm^3 of potassium iodide in 90 cm^3 of distilled water was added into the content of the flask using a measuring cylinder. The content was titrated with 0.1 M sodium thiosulphate solution prepared by dissolving 3.95 g of anhydrous $Na_2S_2O_3$ in 250 cm^3 of distilled water. Few drops of 1% starch indicator were added and the titration continued by adding the sodium thiosulphate drop wise until coloration disappeared after vigorously shaking. The same procedure was used for the blank test. The Iodine Value (I.V.) is given by the expression:

$$\text{Iodine Value (I.V.)} = \frac{126.9\ C\ (V1 - V2)}{M}$$

where, C = concentration of sodium thiosulphate, V_1 = volume of sodium thiosulphate used for blank, V_2 = volume of sodium thiosulphate used, M = mass of sample while 12.69= constant.

Determination of specific gravity

Specific gravity bottles will be washed, rinsed with acetone and dried at room temperature in a desiccator and the weight of the empty bottles determined using an electronic weighing balance. The weight of the bottle filled with water will also be recorded. The same procedure will be repeated with the oil and the specific gravity computed as follows;

$$\text{Specific gravity} = \frac{W2 - W1}{W3 - W1}$$

where, W_1 = weight of empty bottle, W_2 = eight of bottle + oil, W_3= weight of bottle + water.

Colour and physical state of oil at room temperature

The oil colour was determined by Oganonetip method, where ten people were called up to visualize the physical appearance of the biodiesel [AOAC, 1975]. While physical state of the oil was determined by sensory evaluation [IBETO & al. 2012].

Determination of the cetane number of the biodiesel

This is a measurement of the combustion quality of diesel fuel during compression ignition. The cetane number of the biodiesel was calculated via the use of empirical formula in the literature using the result of saponification number (SN) and the iodine value (IV) of biodiesel [AOAC, 2000].

Proximate composition analysis

Proximate composition (crude proteins, crude lipids, fibre, moisture and ash) of the seeds of the sampled cucurbits were determined using the methods of [AOAC, 1990] while carbohydrate was determined by difference. The calorific values in kilo joule (k) were calculated by multiplying the crude fat, protein and carbohydrate by Atwater factors of (k) 37, 17, and 17 respectively.

Mineral composition analysis

The minerals were analyzed by first dry ashing the samples at 550 ºC in the muffle furnace. The filtered solutions were used to determine Na, K, Ca, Mg, P and N by means of atomic absorption spectrophotometer (AAS). Phosphorus was determined calorimetrically by using the phosphovanado molybdate method [AOAC, 2008].

Data Analysis

Treatments were replicated three times and results have been presented as means ± S.D. of the values. The results obtained were subjected to one way Analysis of Variance (ANOVA). Same superscripts means that there was no significant difference ($P \leq 0.05$) and where the superscripts differ, it means that there was a significant difference ($P \leq 0.05$).

Results and discussion

Percentage yield and physiochemical properties of the seed oil of *S. indicum* and *M. oleifera*

The table below gives the results of biodiesel yield (%) and its physico-chemical properties for sampled *S. indicum* and *M. oleifera* seeds. Percentage moisture of the two seed oils revealed 3.66% obtained in *S. indicum* while 4.23% was obtained in *M. oleifera*. The yield of seed oil was both appreciable with 54.65% obtained in *S. indicum* while in *M. oleifera*, 39.33% was obtained with significant difference between the two species. Acid value of 34.32 $mgKOHg^{-1}$ was obtained in *S. indicum* while 29.98 $mgKOHg^{-1}$ was obtained in *M. oleifera*. Moisture Percent 3.66±0.54 was obtained in *S. indicum* while 4.23±0.87 was obtained in *M. oleifera*. For *S. indicum,* 148.82 mg KOH/g was obtained as the saponification value while 127.86 mg KOH/g was that obtained for *M. oleifera*. Iodine value obtained in *S. indicum* was

128.56 g I_2/100g while in *M. oleifera*; it was 103.68 g I_2/100g. For kinematic viscosity 0.97 mm^2/s was obtained in *S. indicum* while 0.78 mm^2/s was obtained in *M. oleifera.* Cetane number, 34.00was obtained in *S. indicum* while 28.00 was obtained in *M. oleifera*. Oil colour in the two samples was found to be yellowish-brown and cream-brown while state of the oil at room temperature was liquid. There was significant difference ($P \leq 0.05$) between the two species in terms of % yield, saponification values and iodine value. Obtained results are in close range to the reported yields of 58.60 and 48.40 as reported by [KARAYE & al. 2020] on Beniseeds and watermelon respectively. Acid value measures the presence of corrosive free-fatty acids and oxidation products. Percentage oil yield obtained in the current study is a bit higher than the reported 36.7% on seed oil of calabash however; obtained specific gravity is in agreement with the reported values by [SOKOTO & al. 2013]. In another study by [IBETO & al. 2012], the following results reported on the seed oil from *Brachystegia eurycoma*, *Cucurbita pepo* and *Luffa cylindrica* were comparable to obtained results in the current study.

Table 1. Physiochemical properties of the seed oil of *S. indicum* and *M. oleifera*

Parameters	**Unit**	***S. indicum***	***M. oleifera***
Moisture	(%)	3.66 ± 0.54^a	4.23 ± 0.87^a
Oil yield	(%)	54.65 ± 2.56^a	39.33 ± 1.10^b
Acid Value	$mgKOHg^{-1}$	34.32 ± 1.67^a	29.98 ± 1.16^a
Saponification value	(mg KOH/g)	148.82 ± 1.78^a	127.86 ± 1.43^b
Kinematic viscosity	(mm^2/s)	0.97 ± 0.07^a	0.78 ± 0.09^a
Specific gravity	g/cm^3	0.89 ± 0.05^a	0.84 ± 0.05^a
Iodine value	(g I_2 /100 g oil)	128.56 ± 2.23^a	103.68 ± 2.19^b
Cetane number	-	34.00 ± 0.47^a	28.00 ± 0.45^a
Oil Colour	-	Yellowish brown	Cream yellow
State of Oil at Room Temp.		Liquid	Liquid

Results have been presented as means ± S.D. of the means. The results obtained were subjected to one way analysis of variance (ANOVA). Same superscripts means that there was no significant difference ($P \leq 0.05$) and where the superscripts differ, it means that there was a significant difference ($P \leq 0.05$).

Proximate Composition of the Seeds *S. indicum* and *M. oleifera.*

Proximate compositions of the seeds of *S. indicum* and *M. oleifera* have been shown in Table 1. From the results, there was significant difference ($P \leq 0.05$) between the two species in the contents of crude lipids, crude fibre, % ash and available energy (kcal/100 g). From the Table, crude protein obtained in *S. indicum* 27.66±1.23% was a bit higher than that of *M. oleifera* with 24.32±1.08% while crude lipid obtained indicated that *S. indicum* had 47.78±1.89% while in *M. oleifera*, it was 28.87±1.12%. For crude carbohydrate, 37.89±1.52% was obtained for *S. indicum* while 34.51±1.35% was obtained in *M. oleifera*. Crude fibre revealed that *S. indicum* had 8.32±0.88% and *M. oleifera* had 14.37±0.98%. Percentage ash contents and available energy showed that *S. indicum* had 5.62±0.76% and 692.22±4.45 k/cal while *M. oleifera* had 15.13±0.97% and 545.91±3.15 k/cal respectively. Results obtained in the current study is a bit higher than the report of [KARAYE & al. 2021] on three Nigerian cucurbits seeds with the range of values of crude proteins, crude lipids and crude carbohydrates as 32.66-35.94%, 24.50-31.33% and 24.06-36.34% respectively. Results obtained in the current study is in disagreement with the report of [NZIKOU& al. 2009] the seeds of *S. indicum* grown in

Congo-Brazzaville with moisture contents, proteins, carbohydrates and crude fibre as 5.7%, 20%, 13.4% and 3.2% respectively.

Table 2. Proximate composition of the seeds *Sesamum indicum* and *Moringa oleifera*

Parameters	*Sesamum indicum*	*Moringa oleifera*
Moisture	4.14±0.18[a]	3.32±0.14[a]
Crude Protein (%)	27.66±1.18[a]	24.32±1.12[a]
Crude Lipid (%)	47.78±1.89[a]	28.87±1.12[b]
Crude Carbohydrate (%)	37.89 ±1.52[a]	34.51±1.36[a]
Crude Fibre (%)	8.32±0.88[a]	14.37±0.98[b]
Ash (%)	5.62±0.76[a]	15.13±0.97[b]
Available Energy (K Cal.)	692.22±4.45[a]	545.91±3.15[b]

Results have been presented as means ± S.D. of the means. The results obtained were subjected to one way Analysis of Variance (ANOVA). Same superscripts means that there was no significant difference (P≤0.05) and where the superscripts differ, it means that there was a significant difference (P≤0.05).

Mineral analysis of the seeds of *S. indicum* and *M. oleifera*

Mineral compositions of the samples were shown in Table 2. Minerals are important in human nutrition. It is a well-known fact that enzymatic activities as well as electrolytic balance of the body fluid are related to adequacy Na, K, Mg and Zn. Potassium is very important in maintaining body fluid volume and osmotic equilibrium, the pH of the body, regulation of muscles and nerve irritability, control of glucose absorption and enhancement of normal retention of protein during growth [ADESINA & ADELEYE, 2016]. From the Table 3, it can be deduced that the two species contain appreciable amounts of valuable nutrients needed for healthy growth and development. Phosphorus contents in the samples revealed that 385.51 mg / 100 g was obtained in *M. oleifera* while it was 254.54 mg / 100 g obtained in *S. indicum*. Potassium is the next in abundance with 198.32 mg / 100 g obtained in *M. oleifera* while in *S. indicum*; 157.97 mg / 100 g was recorded. Calcium is another vital mineral obtained in both the seeds with appreciable composition of 198.32 mg / 100 g obtained in *M. oleifera* while 157.97 mg / 100 g was recorded in *S. indicum*. Magnesium is the next in the series with 144.96 mg / 100 g] obtained in *M. oleifera* while in *S. indicum*; 118.13 mg / 100 g was recorded. Sodium is the next in abundance with 135.87 mg /100 g in *M. oleifera* while 112.43 mg / 100 g was obtained in *S. indicum*. Manganese is the other vital elements contained by the two seeds with 112.14 mg / 100 g obtained in *S. indicum* while the higher value 147.83 mg / 100 g was obtained in *M. oleifera*. Cupper is the other vital elements contained appreciably by the two seeds with 124.13 mg / 100 g obtained in *S. indicum* while 145.87 mg /100 g was obtained in *M. oleifera*. Zinc is other vital element obtained in the seeds with (12.87 mg / 100 g) in *S. indicum* while in *M. oleifera*; 31.84 mg / 100 g was obtained. The present result is lower than that reported in another study by [OKUDU & al. 2016] with sodium 235.74 mg / 100 g, calcium 428.78 mg / 100 g and magnesium 184.12 mg / 100 g. Obtained results were however; lower than the reported 466.03 mg / 100 g, 184.12 mg / 100 g, 428.78 mg / 100 g and 235.74 mg / 100 g as for potassium, magnesium, calcium and sodium by BORCHANI & al. (2010). However, it has been reported that climatic factors and stages of maturity could cause variation in distribution of the phytochemicals [BAMISHAIYE & al. 2011].

Table 3. Result of mineral analysis of the seeds of *Sesamum indicum* and *Moringa oleifera* using (AAS) presented as mg / 100 g

Minerals	*Sesamum indicum*	*Moringa oleifera*
K	157.97±2.12[a]	198.32±3.80[b]
Mg	118.13±1.48[a]	144.96±3.66[b]
P	254.54±2.06[a]	385.51±4.96[b]
Ca	166.70±1.85[a]	295.20±2.61[b]
Mn	112.14±1.31[a]	147.83±1.19[b]
Na	121.43±2.13[a]	145.87±2.56[b]
Cu	124.13±1.08[a]	162.81±2.63[b]
Zn	12.87±1.09[a]	31.84±1.67[b]
Ni	3.95±0.51[a]	16.07±1.68[b]
Cr	3.32±0.11[a]	2.22±0.21[a]
Cd	0.03±0.09[a]	0.28±008[a]

Results have been presented as means ± S.D. of the means. The results obtained were subjected to one way Analysis of Variance (ANOVA). Same superscripts means that there was no significant difference (P≤0.05) and where the superscripts differ, it means that there was a significant difference (P≤0.05).

Conclusion

To conclude, it can be asserted that the two seed samples are endowed with multiple benefits that if incorporated into daily diets of the populace, they could go a long way in providing succor to the fight against hunger and malnutrition especially in the developing world. This is in addition to the fuel they contain that could play a vital role in providing income to the poor populace.

Conflict of interest

Authors hereby declare that there is no competing interest of any sort among them.

References

ADESINA A. J. & ADELEYE E. I. 2016. Comparative evaluation of the levels of minerals and mineral safety index of raw, roasted and cooked *Treculia africana* seeds flour. *Journal of Food Science and Technology Nepal.* **9**: 1-19. https://doi.org/10.3126/jfstn.v9i0.13459

AJIBOLA V. O., ABECHI S. E. & YUSUF J. 2018. Evaluation of *Momordica balsamina* seed oil for its potential as feedstock for biodiesel production. *Physical Science International Journal.* **17**(3): 1-9. https://doi.org/10.9734/PSIJ/2018/37547

AOAC. 1975. *Official Methods of Analysis.* 11th edition. Association Official Analytical Chemists. Washington DC: 51-52. www.scirp.org

AOAC. 1990. *Official Methods of Analysis.* 14th edition. Association Official Analytical Chemists. Washington DC.

AOAC. 2000. *Official Methods of Analysis* 17th edition. The Association Official Analytical Chemists. Gaithersburg, MD, USA.

AOAC. 2008. *Official Methods of Analysis.* AOAC International, 18th edition. Suite 500, Gaithersburg, MD 20877, Washington DC, USA.www.aoac.org

BAMISHAIYE E. I., OLAYEMI F. F., AWAGU F. & BAMISHAIYE O. M. 2011. Proximate and phytochemical composition of *Moringa oleifera* leaves at three stages of maturation. *Advance Journal of Food Science and Technology.* **3**(4): 233-237.

BORCHANI C., BESBES S., BLECKER C. & ATTIA H. 2010. Chemical characteristics and oxidative stability of sesame seeds, sesame paste, and olive oils. *Journal of Agricultural Sciences and Technology.* **12**(5): 585-596.

BUKAR A., UBA A. & OYEYI T. 2010. Antimicrobial profile of *Moringa oleifera* Lam. extracts against some food-borne microorganisms. *Bayero Journal of Pure and Applied Sciences.* **3**(1): 43-48.

DUTTA A. C. 2004. *Botany for Degree Students*, 5th edition, Macmillan Publisher, 52 Oxford University Press, India, 708 pp. https://doi.org/10.4314/bajopas.v3i1.58706

IBETO C. N., OKOYE C. O. B. & OFOEFULE A. U. 2012. Comparative study of the physicochemical characterization of some oils as potential feedstock for biodiesel production. *International Scholarly Research Network* (ISRN), *Renewable Energy.* Article ID 621518, **10**: 1-5. https://doi.org/10.5402/2012/621518

JAHN S. A. A. 1984. Effectiveness of traditional flocculants as primary coagulants and coagulant aid for treatment of tropical raw water with more than a thousand fold fluctuation in turbidity. *Water Supply.* **6**: 8-10.

KARAYE I. U., LADAN M. U., SHEHU Z. H., ADILI I. S., LAWAL H. M. & SHEHU A. 2020. Biochemical characterization of seed oil in sesame and watermelon for production of biodiesel. *International Journal of Science for Global Sustainability.* **6**(2): 1-9.

KARAYE I. U., HAYATU M., MUSTAPHA Y. & SANI L. A. 2021. Nutritional and anti-nutritional properties of the seeds of six selected Nigerian cucurbit germplasm. *Journal of Plant Development.* **28**: 139-150. https://doi.org/10.47743/jpd.2021.28.1.878

KARAYE I. U., HAYATU M., MUSTAPHA Y. & SANI L. A. 2022. Quantification and Analysis of three Nigerian cucurbits. *Savanna Journal of Basic and Applied Sciences.* **4**(1): 1-8.

MAKINDE F. M. & AKINOSO R. 2013. Nutrient composition and effect of processing treatments on antinutritional factors of Nigerian Sesame (*Sesamum indicum* Linn.) cultivars. *International Food Research Journal.* **20**(5): 2293-2300.

NAERLS. 2010. National Agricultural Extension and Research Liaison Services (NAERLS). *Beniseed Production and Utilization in Nigeria*. Extension Bulletin No. 154, Horticultural Series No. 5, 17/7/2011.

NZIKOU J. M., MATOS L., BOUANGA-KALOU G., NDANGUI C. B., PAMBOU-TOBI N. P. G., KIMBONGUILA A., SILOU T., LIDER M. & DESOBRY S. 2009. Chemical composition on the seeds and oil of sesame (*Sesamum indicum* L.) grown in Congo-Brazzaville. *Advance Journal of Food Science and Technology.* **1**(1): 6-11.

ODUGBEMI T. 2006. *Outline and pictures of medicinal plants from Nigeria.* University of Lagos Press, Yaba, Lagos-Nigeria. 283 pp.

OKUDU H. O., OGUIZU A. D. & NWAOKORO C. F. 2016. Nutrients and anti-nutrients contents of white beniseed cultivar (*Sesamum indicum* L.) in Nigeria. *Direct Research Journal of Agriculture and Food Sciences.* **4**(10): 290-293.

OLUDURO A. O. 2012. Evaluation of antimicrobial properties and nutritional potentials of *Moringa oleifera* Lam. leaf in South Western Nigeria. *Malaysian Journal of Microbiology.* **8**(2): 59-67. https://doi.org/10.21161/MJM.02912

SOKOTO M. A., HASSAN L., SALLEH M. A., DANGOGGO S. & AHMAD H. 2013. Quality assessment and optimization of biodiesel from *Lagenaria vulgaris* (Calabash) seeds oil. *International Journal of Pure and Applied Sciences and Technology.* **15**(1): 55-66.

YOSHIDA H., ABE S., HIRAKAWA Y. & TAGAGI S. 2001. Roasting effects on fatty acid distributions of triacylglycerols and phospholipids in sesame (*Sesamum indicum*) seeds. *Journal of the Science of Food and Agriculture*. **81**(7): 620-626. https://doi.org/10.1002/jsfa.857

How to cite this article:

KARAYE I. U., MAISHANU S. M., ANKA S. A., SHEHU A., ADILI S. I., MUHAMMAD L. H. & MUSA A. 2022. Nutritional and extractable oil profile in seeds of *Sesamum indicum* L. and *Moringa oleifera* Lam. grown in Sokoto, Nigeria. *J. Plant Develop*. **29**: 69-77. https://doi.org/10.47743/jpd.2022.29.1.904